Climate change beliefs and savings behavior: a macroeconomic perspective

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Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- **But:** large uncertainty over extent (physical, policy)

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1. Do beliefs over climate change affect individual savings?
2. What are the macroeconomic implications of climate concern via capital accumulation?
3. Does disagreement over climate impacts matter on aggregate? Distributionally?

This paper: micro to macro

Micro behavior

Macro effects

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Micro behavior

- Analytical consumption-savings model in partial equilibrium
- Empirical evidence

Macro effects

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Micro behavior

- Analytical consumption-savings model in partial equilibrium
  - ➢ savings response to productivity effects ≥ 0
  - ➢ Depends on idiosyncratic state: MPS, state-dependent value of savings
- Empirical evidence

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    1. UK Understanding Society Survey
    2. Online survey

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  1. UK Understanding Society Survey
     - ➢ Significant positive correlation between climate change concern index and savings choices
     - ➢ For most versus least concerned: 9.4% more likely to save, 1.6 pp. increase in savings share.
  2. Online survey

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        - within-subject design: Savings choice under two scenarios
        - average increase of savings

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- Krusell-Smith model with non-stationary shift
- Aggregate, distributional and individual outcomes along the transition

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Macro effects

- Krusell-Smith model with non-stationary shift
  - ➢ novel solution method based on stratified sampling
  - ➢ varying belief over trend in productivity impacts (mean and variance)
- Aggregate, distributional and individual outcomes along the transition

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Macro effects

- Krusell-Smith model with non-stationary shift
- Aggregate, distributional and individual outcomes along the transition
  - ➢ Climate concern effect on capital partly offsets exogenous physical damages
  - ➢ Higher capital: labor income $\uparrow$, wealth inequality $\downarrow$

Literature and contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
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Contribution: joint focus on individual choices and uncertainty

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Disagreement over aggregate (climate) processes

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Heterogeneous agents and aggregate risks

- Krusell and Smith (1998), Broer et al. (2022)

Contribution: Non-stationarity, novel solution method for perceived law of motion

Predictions in partial equilibrium

Consumption savings problem

Two types of uncertainty:

- Idiosyncratic $\phi \in \Phi$: skills and demographics
- Aggregate $\zeta \in Z = \{\zeta^L, \zeta^H\}$: productivity

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Agent i chooses consumption to maximize expected utility over life-time

$$\max_{c_{it}} \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_{it})\right].$$

under some probability distribution, subject to budget constraint

$$c_{it} + a_{it+1} = y(\zeta_t, \phi_{it}) + R(\zeta_t) a_{it}, \;\; a_{it+1} \geq 0.$$

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For multiplicative productivity shocks: $R(\zeta^L) < R(\zeta^H)$, $y(\zeta^L, \cdot) < y(\zeta^H, \cdot)$, but

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How does consumption respond to a rise in the probability p_t of ζ^L?

First order consumption response

Implicit function theorem on Euler equation:

$$\frac{dc_0}{c_0} = -\varepsilon(c_0) \sum_{t=0}^{\infty} \left(\sum_{\theta^t} \mathbb{P}^*(\theta^t) \left(\prod_{j=0}^{t} MPS(\theta^j) \right) \mathcal{D}_t(\theta^t) \right) dp_{t+1}. \tag{1}$$

Drivers of response:

- $MPS = da/dy_0 = 1 - dc/dy_0$: marginal propensity to save;
- $\varepsilon(c) = -u'(c)/(cu''(c))$: elasticity of intertemporal substitution;
- $\mathcal{D}_t(\theta^t)$: expected marginal value of holding an extra unit of assets in low versus high state
- $\mathbb{P}^*$: risk-adjusted probability measure over θ^t

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Dependence on idiosyncratic state:

- ➤ MPS: small if borrowing constraint
- ➤ $\mathcal{D}_t(\theta^t)$: high for low asset holding and low expected income
- ➤ $\mathbb{P}^*$: larger weight on bad states

Empirical evidence

Data and empirical strategy

UK Longitudinal Household Survey, waves 4 and 10

- Construct index about climate change concern
- Savings variables (binary and amount)
- Demographic indicators
  - education, income, residence (LSOA), age, children

Exposure

- Flood data matched on residence

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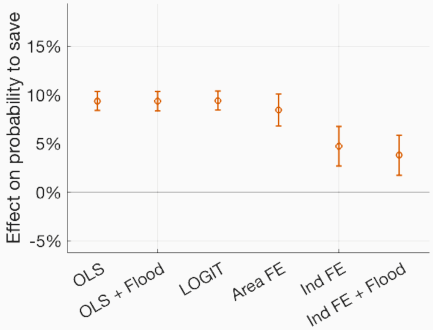
Relationship $s = G(\beta_0 + \beta_1 \iota^C + \beta_2 X)$. Address two main concerns

1. Preferences over risk and time $\rightarrow$ Individual ixed effects
2. Idiosyncratic exposure $\rightarrow$ flood exposure, area fixed effects

Empirical results

- Average marginal effect of CC index on savings decision: 9.3% more likely to save.
- Effect of CC index on saving relative to income: 0.9% more of income saved
- Individual FE: smaller effect, but positive and significant on extensive margin
- Restriction to subsamples shows higher effect sizes for lowest compared to highest quintile.



Online Survey

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Take-aways and open questions

Key take-aways

- The passthrough of adverse macro risks to savings is non-negative; depends on current idiosyncratic state.
- Empirical evidence shows relationship between climate concern and savings behavior, which cannot be fully attributed to preferences or exposure.

Open questions

- How does capital accumulation react to changes in disaster risk, allowing for indirect effects through savings adjustments?
- How does disagreement over aggregate risks transmit to the macroeconomy?

$\rightarrow$ Dynamic general equilibrium model

General Equilibrium Model

Extension of Krusell-Smith

Households

- idiosyncratic income and asset holdings
- subject to idiosyncratic shocks
- consume and save to maximize EU, subject to budget constraint

Representative firm

- subject to productivity shocks ζ_t

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Climate change: non-stationary shift in temperature $T_{t+1} = \mu_T + \nu(T_t - \mu_T)$ for $t \geq 0$.
How does this change affect the economy?

Climate change impacts

Probability of aggregate shock is given by

$$(\mathbb{P}(\zeta_t = \zeta^L) = p_t = p(T_t) = p^{1-\gamma T_t}.$$

Beliefs over γ

- Two possible states the world: $\gamma \in \{0,\ \overline{\gamma}\}$
- Certainty about $\overline{\gamma}$, temperature process T_t, current and past values of ζ
- Each agent has a subjective belief

$$\mathbb{P}(\gamma = \overline{\gamma}) = \pi_{it}.$$

- Bayesian updating

$$\pi_{it} = \pi_{it-1}\mathcal{P}_{it}, \text{ where } \mathcal{P}_{it}^{-1} = \begin{cases} \pi_{it-1} + (1-\pi_{it-1})p^{\overline{\gamma}T_t} & \text{if } \zeta_t = \zeta^L \\ \pi_{it-1} + (1-\pi_{it-1})\frac{1-p}{1-p^{1-\overline{\gamma}T_t}} & \text{if } \zeta_t = \zeta^H. \end{cases} \tag{2}$$

Differences in mean and variance, implicit level effect.

Equilibrium and solution

Capital is endogenous: Agents use Perceived Law of Motion (PLM)

Definition (Dynamic equilibrium)

For given processes $\{\zeta_t\}_{t\geq 0}, \{T_t\}_{t\geq 0}$, an initial distribution Ψ_0 and a PLM $\mathcal{H}(K, \zeta, T; \mathcal{X})$, the *dynamic equilibrium* of the economy is given by a sequence $\{\Psi_t\}_{t\geq 0}$ so that:

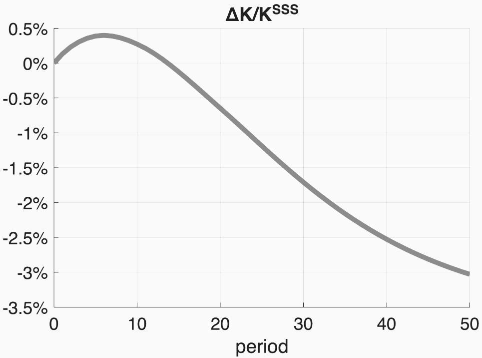
(a) Each period, the economy is in temporary equilibrium.

(b) The distribution evolves consistently with the exogenous law of motion for demographics, Bayes' formula, and the endogenous choice function a':

$$\Psi_t(\phi', a', \pi') = \int_{a'(\phi,a,\pi,K_t,\zeta_t,T_t)=a'} \int_{\phi} \int_{\tilde{\pi}(\zeta_t,\pi)=\pi'} \Psi_{t-1}(\phi, a, \pi) M(\phi', \phi)$$

Solving the model: PLM is temperature and belief dependent. Stratified sampling for convergence.

Capital accumulation



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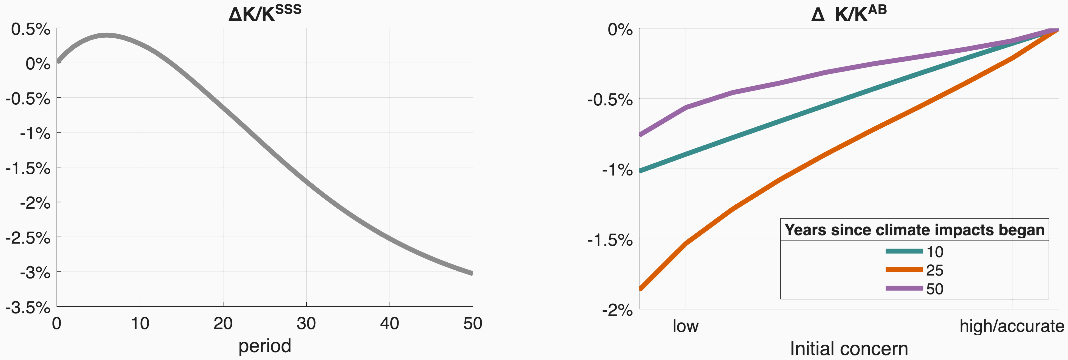
Capital accumulation



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Conclusion

- Micro evidence: climate change affects savings behavior
- On aggregate, this matters:
    - Capital accumulation mitigates climate damages

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